REMARKS/ARGUMENT

Claims 1-32 are pending in the present application. Claims 1-15 and 22-32 are withdrawn from consideration. Claims 16-21 are rejected. Claims 16, 20 and 21 are amended. No new matter is added.

DISCLOSURE OF INFORMATION

The Office Action specifies a request for information regarding Reference No. 5 on page 35 found in the reference by Calderbank et al., "Wavelet Transforms That Map Integers to Integers." The Reference No. 5 described by Calderbank et al. is an article offered by Hongyang Chao and Paul S. Fisher, entitled "An Approach of Fast Integer Reversible Wavelet Transform for Image Compression." The reference quotation by Calderbank et al. notes that the Chao and Fisher reference is a preprint.

In response, Applicants refer to the Examiner to pages B23-B43 of the specification as filed. These pages contain the requested reference by Chau and Fisher in its entirety. Applicants note that this reference was available in preprint form at the time of publication by Calderbank et al., as indicated by the Statement in Calderbank et al.:

> "after finishing this work, we learned that a construction similar to the one presented in section 3 was obtained independently by…Chao-Fischer [sic]."

Accordingly, the date of the reference is approximately that of Calderbank et al., and the reference does not constitute a bar under 35 U.S.C. §102.

DISCLOSURE

The specification is objected to for containing browser executable code in contravention of USPTO policy, according to the Office Action. Applicants have amended the specification to remove code that might be considered to be browser executable, and have instead indicated that a web page link is to be inserted in the appropriate location in the example of the code generated by the image map editor. Applicants respectfully submit that the objection to the disclosure should now be overcome, and

further respectfully note that the code generated by the image map editor is not intended to be executable, but is provided as an example of the operation of the present invention in accordance with the requirements of 35 U.S.C. §112, first paragraph. Accordingly, Applicants respectfully request that the objection to the specification be reconsidered and withdrawn.

CLAIM REJECTIONS - 35 U.S.C. §103

Claims 16-20 are rejected under 35 U.S.C. §103(a) as being unpatentable over the combination of Chui et al. (U.S. Patent No. 5,604,824), Calderbank et al. (Wavelet Transforms That Map Integers to Integers) and Said et al. (An Image Multi Resolution Representation for Lossless and Lossy Compression). In particular, the Office Action states that the combination of Chui et al., Calderbank et al. and Said et al. disclose an image compression system with a compressor for providing a compressed image based on an integer wavelet transform involving a lifting scheme or a correction method, in which the wavelet coefficients have the same finite number of bits as the pixels of the image. The rejection is respectfully traversed.

It is well known that three basic criteria must be met to establish a prima facie case of obviousness. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference which combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. MPEP § 2142. A prima facie case of obviousness can only be established for a claimed invention if all the claim limitations are taught or suggested by the prior art. MPEP § 2143.03. Applicants respectfully submit that a prima facie case of obviousness has not been established with regard to claims 16-20.

The Office Action states that Chiu et al. suggest that the wavelet coefficients of the integer wavelet transform have the same finite number of bits as the pixels of the image that is compressed. The Office Action states as support for this position that the wavelet transform described by Chiu et al. does not change the number of bits from the input of the transform to the output of the transform. Applicants respectfully believe that this reading of the Chiu et al. reference suggested by the Office Action ignores the formation of wavelet transform coefficients. According to the recitation in the claims, it is the wavelet coefficients that are represented by the same number of bits as the pixels of the input image. The disclosure by Chiu et al. at most indicates that the pixels of the image resulting from the transform

output can be represented by the same number of bits as the pixels of the input image. Accordingly, Applicants respectfully submit that Chiu et al. do not suggest, or teach, that integer wavelet transform coefficients may be represented by the same number of bits as are the pixels of the input image, which is the subject matter recited in claims 16-20 of the present invention.

Indeed, all the disclosures cited in the Office Action discuss techniques for wavelet transforms that require at least twice the number of bits to represent wavelet coefficients, than were used to represent the pixels of the original image. Nowhere in any of these cited references do any of the authors state or describe that the wavelet coefficients in any type of transform have the same number of bits as represent the pixels of the original image. Applicants respectfully aver that to the extent that the Office Action reads the references as describing wavelet coefficients represented by the same number of bits as is used to represent the pixels of the original image, the Office Action is relying on shear hindsight reconstruction to assign to the prior art subject matter that it does not, in fact, contain, and can only be gleaned from Applicants' disclosure. .

Indeed, the Office Action cites Calderbank et al. for the proposition that it is conventional to provide wavelet coefficients represented by the same number of bits as is used to represent the original image pixels. Yet, Calderbank et al. state explicitly on page 35 just before the recitation of the references, that:

> "The Chao-Fischer [sic-the inventors] approach has the extra feature that it uses modular arithmetic to ***eliminate all increase in dynamic range***; thus if the original image uses 8 bits per pixel, all the wavelet coefficients uses [sic] 8 bits as well."

Accordingly, Calderbank et al. specifically state their approach provides an increase in dynamic range of the number of bits required to represent wavelet coefficients. This increase in dynamic range that requires further numbers of bits to represent the wavelet coefficients is common to the techniques of Chui et al. and Said et al. as well. Accordingly, Applicants respectfully submit that the cited references, either alone or in combination, do not disclose the limitation recited in claims 16-20, where the wavelet coefficients of the integer wavelet transform have the same finite number of bits as the pixels of the image. Applicants thus respectfully aver that a *prima facie* case of obviousness cannot be established against claims 16-20 on the basis of the cited prior art references.

The Office Action also states that Chui et al. do not disclose or suggest a lifting scheme to obtain integer wavelet transforms. The Office Action further states that Calderbank et al. teach that it is well known to use a lifting scheme for integer wavelet transforms. Yet, the disclosure by Chui et al. appears to deal only with spline-wavelet transforms (title, abstract col. 8, lines 10-27). However, Chiu et al. fail to disclose or suggest any use of, or motivation for, the use of a lifting technique applied to spline-wavelet compression and reconstruction. Indeed, the spline-wavelet transforms disclosed by Chui et al. do not appear to include proper truncations. However, the lifting scheme described by Calderbank et al. provides for an integer transform using simple truncation while maintaining invertability (e.g., Section 3.1, last paragraph). Because the content of these two references argue against their combination, Applicants respectfully submit that there is no suggestion or motivation to combine the references as described in the Office Action to produce the present invention. Indeed, Applicants respectfully submit that even if the references of Chui et al. and Calderbank et al. could be combined, the result would be unworkable, as regards the invention recited in claims 16-20, because of the loss of utility in the spline-wavelet transforms having truncated coefficients. Accordingly, Applicants submit that a *prima facie* case of obviousness cannot be established against the present invention as recited in claims 16-20, on the basis of the disclosures by Chui et al. and Calderbank et al.

The Office Action further states that Chui et al. do not teach or suggest a correction method used in connection with integer wavelet transforms. The Office Action states that Said et al. teach that it is well known to use a correction method for integer wavelet transforms, which in combination with the disclosure by Chui et al., makes the present invention obvious. Applicants respectfully disagree with the conclusion stated in the Office Action.

As discussed above, Chui et al. disclose a transform technique that is exclusively limited to spline wavelet transforms. The technique of spline-wavelet transform does not permit truncation of wavelet coefficients. However, the disclosure by Said et al. call for an S+P-transform in which either truncation is ignored, or applied to the prediction value of the transform (page 1304, equation 4; page 1305, last paragraph of section II). Accordingly, Applicants respectfully submit that neither the subject matter of Chui et al. nor Said et al. provide motivation for the combination of the references, since the spline-wavelet transforms discussed by Chui et al. do not include truncation, and the disclosure by Said et al. makes no mention of use of the S+P-transform with spline-wavelet transforms. Applicants thus

respectfully submit that a *prima facie* case of obviousness cannot be established on the basis of the combination of the references by Chui et al. and Said et al.

The Office Action further states that Chiu et al. suggests integer wavelet transform coefficients represented by the same number of finite bits as the pixels of the image. As discussed above, Applicants respectfully aver that Chui et al. make no mention of a same fixed number of bits for representation of integer wavelet transform coefficients and image pixels. Indeed, Applicants respectfully challenge the Examiner to specifically indicate this feature of the present invention in any of the cited prior art references. In the absence of any showing of this limitation recited in the prior art, Applicants respectfully submit that claims 16-20 contain limitations not taught or suggested in any of the prior art references. Accordingly, Applicants respectfully submit that a prima facie case of obviousness cannot be made against claims 16-20 based on the disclosures of the cited prior art references.

The Office Action also states that Said et al. provide for the conventionality of the claimed "same finite number of bits." However, the pertinent sections of the disclosure by Said et al. state that:

> "Note that the maximum number of bits required to represent each pixel in the *ll* images does not change with each transformation. For example, if the gray-level original image has 8 b/pixel, the reduced *ll* image also has 8 b/pixel. On the other hand, the other pixels require a signed representation with a ***larger*** number of bits" (emphasis added).

This discussion by Said et al. contains absolutely no reference to wavelet coefficients, but rather discusses only images. Indeed, even if the disclosure by Said et al. could be said to show any relationship between wavelet coefficient bit representations and image pixel bit representations, the *ll* image appears to be the only transformed image capable of having coefficients being represented by the same number of bits as are the image pixels. Said et al. specifically require a larger number, i.e., greater number of bits for the other pixel representations. Accordingly, the present invention described in claims 16-20 contain limitations neither taught nor suggested in the cited prior art reference. In the absence of a disclosure or suggestion for all the limitations in the claims, a prima facie case of obviousness cannot be made. MPEP § 2143.03. Indeed, Applicants respectfully submit that to the extent the Office Action purports to support the stated conclusion from the disclosures of Chui et al. or

Said et al., Applicants respectfully aver that such a causal connection can only be supported through the vehicle of inappropriate hindsight reconstruction.

Regarding claims 17-19, Applicants note that these claims depend upon and further limit claim 16, and are thought allowable as depending upon an allowable base claim, in view of the above discussion, and in addition to the further limitations each claim contains. Accordingly, claims 17-19 are thought to be allowable.

In view of the above discussion, the rejection of claims 16-20 under 35 U.S.C. §103(a) for obviousness is believed to be overcome, and Applicants respectfully request that the rejection be reconsidered and withdrawn.

Claim 21 is rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Chiu et al., Calderbank et al., Said et al., and further in view of Rich et al. (U.S. Patent No. 5,831,625). Applicants respectfully submit that discussion above with regard to claims 16-20 is applicable to the rejection of claim 21. Accordingly, it is believed that claim 21 recites limitations neither disclosed nor suggested by any of the cited prior art references. For example, as discussed above, none of the cited prior art references disclose wavelet coefficients that have the same finite number of bits as the pixels of the input image. Because the claims contain at least one limitation neither disclosed nor suggested by any of the cited prior art references, Applicants respectfully submit that claim 21 should not be considered obvious over the cited prior art references. MPEP § 2143.03. Accordingly, Applicants respectfully believe that the rejection of claim 21 under 35 U.S.C. § 103(a) is overcome, and respectfully request that the rejection be reconsidered and withdrawn.

Applicants further note that the above discussion with regard to the cited prior art references is applicable to the comments provided by the Examiner in response to Applicant's arguments filed October 3, 2000. Accordingly, Applicants submit that the recitation in Calderbank et al. that is used in support of the rejection of the claims actually is derived from the inventor's own disclosure, as indicated in the present specification, above. In addition, Applicants respectfully submit that, as discussed above, Said et al. do not recite the feature of the same number of bits used in the representation of coefficients of an integer wavelet transform as is used to represent the number of pixels in an input image. Instead, Said et al. appear to be referring to the number of bits used to represent a pixel in each of the transformed images, rather than the number of bits used to represent the coefficients of the integer wavelet transform. Even if the disclosure by Said et al. could be said to be disclosing a relationship of

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bits to coefficients, such a relationship would involve only one quadrant of wavelet coefficients at each transform level. Such a relationship, if disclosed at all, still would lack the limitations recited in the claims of the present invention, as discussed above. Accordingly, Applicants respectfully request that the rejection of claims 16-21 be reconsidered, and that the rejection be withdrawn.

CONCLUSION

Applicants respectfully believe that the foregoing is a complete and accurate response to all issues raised in the most recent Office Action. It is further believed that this response raises no new issues or matters that require further search, but instead places the application in better form for allowance. In view of the above discussion, Applicants respectfully submit that the present application is now in condition for allowance, and earnestly solicit notice to that effect.

If it is believed that an interview would contribute to allowance of the claims, the Examiner is requested to contact the undersigned counsel at the number provided below.

I hereby certify that this correspondence is being sent by facsimile to the Patent and Trademark Office at facsimile number 703-872-9314 on January 8, 2002 by:

Brendan Kennedy
Name of applicant, assignee or Registered Representative

Brendan Kennedy
Signature

January 8, 2002
Date of Signature

Respectfully submitted,

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BJK:gl

APPENDIX A
"CLEAN" VERSION OF EACH PARAGRAPH/SECTION/CLAIM
37 C.F.R. § 1.121(b)(ii) AND (c)(i)

SPECIFICATION:

Replacement for the paragraph at page 1, line 29 to page 2, line 2:

B3 In addition to imaging systems, compression technology can be incorporated into "video on demand" systems, such as video servers. Compression technology can also be applied to streaming video, which is the real-time capture and display of video images over a communications link. Applications for streaming video include video telephones, remote security systems, and other types of monitoring systems.

Replacement for the paragraph at page 4, line 18, to page 4, line 22:

B4 According to another aspect of the present invention, a compression method is provided that allows user selected portions of an image to be compressed to different image qualities, thereby permitting non-uniform image compression.

Replacement for the paragraph at page 16, line 1 to page 16, line 10:

B5 The image source 72 may be a digital still image or video source, such as a CD-ROM drive, scanner, or network connection. In addition, the image source 72 can include analog video sources, such as a video camera, VCR, television broadcast or cable receiver. The analog video signals would be converted to a digital form by the image source 72 using conventional conversion techniques. Alternatively, an image source 72 can include a video camera and communications systems for transmitting real-time video to the I/O subsystem 66.

Replacement for the paragraph at page 19, line 29 to page 20, line 7:

B6 FIG. 12 illustrates another method of compressing an image in accordance with another embodiment of the present invention. In this method, a user can selectively vary compression parameters (step 173) to obtain a lossless or near-lossless compressed image at a desired compression ratio. In step 170, the image is input. In step 172, an integer color transform is

B6

performed on the input image. In step 173, compression parameters are selected by the user using a software interface. These parameters can include those described herein below in the subsection title "Peak Signal to Noise Ratio (PSNR) Controlled Compression". In step 174, an integer wavelet transform is performed on the color transformed pixels. In step 176, the wavelet coefficients are entropy coded. Next, in step 178, the compressed image file is then output from the system.

Replacement for the paragraph at page 24, line 1 to page 24, line 6:

B7

REMARK. Since (2.1)-(2.5) are not linear because of the rounding operation Int(x), this means the transformation order becomes significant. For instance, if the decomposition was applied first to the columns and then to the rows, the inverse transformation must be applied first to the rows and then to the columns.

Replacement for the paragraph at page 24, line 31, to page 25, line 9:

B8

It is known that the general values for the high frequency wavelet coefficients are small, and all higher levels of the decomposition provide generally small values in the high frequency band. This allows the preservation of precision during the computational stage of the wavelet coefficients. Now, the complementary code property, the other aspect of the PPP property, is a well know characteristic of the integer arithmetic as done by the computer. Consider the computation of the difference of two integers given as $c = b - a$ and the inverse computation of $a = b - c$. the nature of the computation within the computer can be specified as follows:

Replacement for the paragraph at page 33, line 17, to page 33, line 20:

B9

Similarly, if we take $\{h^0, \bar{h}, g, \tilde{g}^0\}$ as an initial set of biorthogonal filters, a new set of biorthogonal filters $\{h, \bar{h}, g, \tilde{g}\}$ can be found as

Replacement for the paragraph at page 45, line 15:

B10

href = "[user assigned http link]" ></EMBED>

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Replacement for the paragraph at page B11, line 15, to page B11, line 16:

B11

<EMBED SRC- "cow.cod" type = "image/cis-cod" WIDTH- "257" poly= "44, 45, 103, 78, 103, 86, 54, 86, 54, 78", href= "[user assigned http link]" ></EMBED>

Claims:

Sub C1

B1

16. (Twice Amended) An image compression system, comprising:

an image source providing an image, the image having a plurality of pixels, each of the pixels having a finite number of bits;

a compressor coupled to the image source, the compressor configured to generate a compressed image based on an integer wavelet transform derived using a technique selected from a lifting scheme and a correction method, wherein wavelet coefficients of the integer wavelet transform have a finite number of bits that are no greater in number than the highest count for the number of bits for any of the pixels of the image.

B2

20. (Twice Amended) An image decompression system, comprising:

a compressed image source providing a compressed image;

a decompressor coupled to the compressed image source, the decompressor configured to generate a decompressed image based on an integer wavelet transform derived using a technique selected from a lifting scheme and a correction method, wherein wavelet coefficients of the integer wavelet transform have a finite number of bits that are no greater in number than a finite number of bits for any of the as pixels of the decompressed image.

21. (Twice Amended) A computer-readable memory storing a computer program for directing a computer system to perform image compression, wherein the computer program implements the steps for performing integer wavelet transformation of an input image having a finite number of bits per pixel, quantizing the wavelet transformed image, applying entropy coding to the quantized image, and outputting a file that includes the entropy coded image, wherein wavelet coefficients of the wavelet transformed image have no more finite number of bits than do any of the pixels of the input image.

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APPENDIX B

VERSION WITH MARKINGS TO SHOW CHANGES MADE 37 C.F.R. § 1.121(b)(iii) AND (c)(ii)

SPECIFICATION:

Paragraph at page 1, line 29 to page 2, line 2:

In addition to imaging systems, compression technology can be incorporated into "video on demand" systems, such as video servers. Compression technology can also be applied to streaming video, which is the real-time capture and display of video images over a communications link. Applications for streaming video include video telephones, remote security systems, and other types of monitoring systems.

Paragraph at page 4, line 18, to page 4, line 22:

According to another aspect of the present invention, a compression method is provided that allows user selected portions of an image to be compressed to different image qualities, [whereby] thereby permitting non-uniform image compression.

Paragraph at page 16, line 1 to page 16, line 10:

The image source 72 may be a digital still image or video source, such as a CD-ROM drive, scanner, or network connection. In addition, the image source [85] 72 can include analog video sources, such as a video camera, VCR, television broadcast or cable receiver. The analog video signals would be converted to a digital form by the image source [85] 72 using conventional conversion techniques. Alternatively, an image source 72 can include a video camera and communications systems for transmitting real-time video to the I/O subsystem 66.

Paragraph at page 19, line 29 to page 20, line 7:

FIG. 12 illustrates another method of compressing an image in accordance with another embodiment of the present invention. In this method, a user can [selective] selectively vary compression parameters (step 173) to obtain a lossless or near-lossless compressed image at a desired compression ratio. In step 170, the image is input. In step 172, an integer color

transform is performed on the input image. In step 173, compression parameters are selected by the user using a software interface. These parameters can include those described herein below in the subsection title "Peak Signal to Noise Ratio (PSNR) Controlled Compression". In step 174, an integer wavelet transform is performed on the color transformed pixels. In step 176, the wavelet coefficients are entropy coded. Next, in step 178, the compressed image file is then output from the system.

Paragraph at page 24, line 1 to page 24, line 6:

REMARK. Since (2.1)-(2.5) [(2-6)] are not linear because of the rounding operation Int(x), this means the transformation order becomes significant. For instance, if the decomposition was applied first to the columns and then to the rows, the inverse transformation must be applied first to the rows and then to the columns.

Paragraph at page 24, line 31, to page 25, line 9:

It is known that the general values for the high frequency wavelet coefficients are small, and all higher levels of the decomposition provide generally small values in the high frequency band. This allows the preservation of precision during the computational stage of the wavelet coefficients. Now, the complementary code property, the other aspect of the PPP property, is a well know characteristic of the integer arithmetic as done by the computer. Consider the computation of the difference of two integers given as $c = b - a$ and the inverse computation of $a = b - c$. the nature of the computation within the computer can be specified as follows:

Paragraph at page 33, line 17, to page 33, line 20:

Similarly, if we take $\{h^0, \tilde{h}, g, \tilde{g}^0\}$ as an initial set of biorthogonal filters, a new set of biorthogonal filters $\{h, \tilde{h}, g, \tilde{g}\}$ can be found as [can be found as]

Paragraph at page 45, line 15:

href = "[http://www.infinop.com] user assigned http link]" ></EMBED>

Paragraph at page B11, line 15, to page B11, line 16:

<EMBED SRC- "cow.cod" type = "image/cis-cod" WIDTH- "257" poly= "44, 45, 103, 78, 103, 86, 54, 86, 54, 78", href = "[http://www.infinop.com] [user assigned http link]" ></EMBED>

Claims:

16. (Twice Amended) An image compression system, comprising:

an image source providing an image, the image having a plurality of pixels, each of the pixels having a finite number of bits;

a compressor coupled to the image source, the compressor configured to generate a compressed image based on an integer wavelet transform derived using a technique selected from a lifting scheme and a correction method, wherein wavelet coefficients of the integer wavelet transform have [the same] a finite number of bits [as the] that are no greater in number than the highest count for the number of bits for any of the pixels of the image.

20. (Twice Amended) An image decompression system, comprising:

a compressed image source providing a compressed image;

a decompressor coupled to the compressed image source, the decompressor configured to generate a decompressed image based on an integer wavelet transform derived using a technique selected from a lifting scheme and a correction method, wherein wavelet coefficients of the integer wavelet transform have a [same] finite number of bits that are no greater in number than a finite number of bits for any of the as pixels of the decompressed image.

21. (Twice Amended) A computer-readable memory storing a computer program for directing a computer system to perform image compression, wherein the computer program implements the steps for performing integer wavelet transformation of an input image having a finite number of bits per pixel, quantizing the wavelet transformed image, applying entropy coding to the quantized image, and outputting a file that includes the entropy coded image, wherein wavelet coefficients of the wavelet transformed image have [the same] no more finite number of bits [as] than do any of the pixels of the input image.